

Historic, Archive Document

Do not assume content reflects current scientific knowledge, policies, or practices.

Reserve
1.9
EN 83 pp

COMPLETE RESEARCH PROGRAM European Corn Borer



U.S. DEPT. OF AGRICULTURE
NATIONAL AGRICULTURAL LIBRARY
OCT 1 - 1963
CURRENT SERIAL RECORDS

United States and Canada

RESEARCH CONFERENCE

✓✓✓
THE fourth annual general conference on European corn borer research is to be held at Washington, D. C., February 11, 1930. The purpose of this meeting, as heretofore, is to provide for a complete coordination of the various research projects, both Federal and State, to arrange for desirable replication of experiments, and to prevent unnecessary duplication. It is intended to have this direct contact with the corn borer research program afford an opportunity for administrative review and constructive criticism to the end that the program, each year, may be in every respect as complete and satisfactory as possible.

The following plans and programs of the Dominion of Canada, United States Department of Agriculture, and the various States have been assembled as the complete program for European corn borer research for 1930. There are also included committee reports as follows:

Joint Report of the Corn Borer Committees of the American Association of Economic Entomologists, American Society of Agronomy, American Society of Agricultural Engineers, American Farm Economic Association, and the American Society of Animal Production.

✓✓
Report of the Committee on Allocation of European Corn Borer Research.

✓
WS
Additional copies of this program may be obtained from the Bureau of Entomology, United States Department of Agriculture, Washington, D. C.

Mr Worthington:-

Extension Material for Ags. Am. Speechist
and Co agents that we have available.

INDEX

	<u>Pages</u>
Canada	1-3
Bureau of Entomology (Sub-index Page 4)	4-35
Bureau of Agricultural Economics	26-27
Bureau of Animal Industry	28-29
Bureau of Chemistry and Soils	30
Bureau of Plant Industry	31-35
Bureau of Public Roads	36-40
Illinois	41-44
Indiana	45-49
Michigan	50-51
New Hampshire	52
New York	53-54
Ohio	55
Pennsylvania	56
Report of the Joint Committee on the European Corn Borer	57-60
Report of the Committee on Allocation of the European Corn Borer Research Work	61-63

CANADA



CANADA



EUROPEAN CORN BORER INVESTIGATIONS

GENERAL PLAN AND PROGRAMME

ENTOMOLOGICAL BRANCH, DEPARTMENT OF AGRICULTURE

FOR CANADA
1930-1931

Mr. Crawford

*2 Canada infested for some distance
no change*

I. Distribution.

(a) Routine annual scouting to determine new territory infested in Quebec and New Brunswick, Nova Scotia, and Prince Edward Island. (In the provinces of Quebec and New Brunswick in cooperation with the local Departments of Agriculture.)

(b) Routine annual scouting to determine status of infestation at selected points in infested territory in Ontario, Quebec, New Brunswick, and Nova Scotia.

(c) The establishment and administration of a quarantine of the infested areas variously restricting the movement of dangerous materials.

(d) The establishment and administration of special restrictions upon seed corn movement.

II. Control. (In cooperation with the Province of Ontario.)

(a) Invention and test of the best farm-made appliances for preparing corn stalks, stubble and refuse for ploughing. (Cont.)

(b) Study of the best combination of farm ploughs and attachments to most effectively and permanently bury the crop refuse upon various soils. (Cont.)

(c) Study of the movement of corn stalks and stubble on the surface of ploughed ground and below ground in relation to culture, with special reference to heaving.

III. Parasite Control.

(a) Importation, rearing and distribution of parasites of the corn borer. (In cooperation with the Bureau of Entomology, U. S. D. A.)

(b) Special studies in the biology, technique of rearing and storing in quantity and the distribution of parasites.

(c) Special studies in the establishment of parasites in the field and the recovery of same in nature.

(d) Special studies in the biology of native parasites.

IV. Life-history, Seasonal Occurrence and Habits.

A. Routine annual studies of the field rate of development of all stages of the insect,

(a) in southern and (b) northern Ontario, (c) in Quebec, (d) in New Brunswick, and (e) in Nova Scotia.

B. Mortality.

(a) Winter mortality, above snow line, under snow cover and under ground at selected points in Ontario and Quebec. (Cont.)

(b) Routine annual mortality study in cultivated fields in refuse (1) above and (2) below ground and at (3) time of emergence.

(c) Mortality of larvae after migrating to the surface from ploughings and hand burials and the factors bringing about the reduction in numbers associated with such burial.

(d) Relation between degree of development of larvae and winter mortality particularly in marginal territory. (Cont.)

C. Larval Establishment and Survival.

(a) A study of the mortality of the early instars and the factors controlling same and its bearing upon degree and rate of increase of infestations in various localities.

D. Migration of Larvae.

(a) Migration of larvae from below ground to and on the surface after ploughing and hand burials; its extent and relation to the reduction in numbers of larvae associated with proper ploughing. (Cont.)

E. Habits of Adults.

(a) Distribution of adults in the individual field and in natural harbors. (Cont.)

(b) Flight habits of adults and factors controlling same in the field.

(c) Egg laying habits of adults and factors controlling the same in the field.

EUROPEAN CORN BORER INVESTIGATIONS

ONTARIO AGRICULTURAL COLLEGE

DEPARTMENT OF ENTOMOLOGY AND ZOOLOGY

I - Control.

- A - Testing the comparative value of the following methods of dealing with corn remnants in the field:
 - 1 - Cutting the stalks level with the ground and cleaning off all remnants and burning them, without plowing.
 - 2 - Lifting the stalks up by the roots in the spring so as to leave no borers under ground, then gathering and burning, without plowing.
 - 3 - Cutting the stalks low, removing them and then plowing the stubble under completely and gathering and burning any that are dragged up in the spring when cultivating the soil or sowing the next crop.
- B - Improving the present farm implements for dealing with corn remnants in the field and devising new and more effective but not costly implements for the same purpose.
- C - Testing of most promising insecticides on Golden Bantam corn.

THE HISTORY OF THE

REPUBLIC OF THE UNITED STATES

OF AMERICA

1776

THE HISTORY OF THE

REPUBLIC OF THE UNITED STATES

OF AMERICA

1776

THE HISTORY OF THE

REPUBLIC OF THE UNITED STATES

1776

OF AMERICA

THE HISTORY OF THE

REPUBLIC OF THE UNITED STATES

OF AMERICA

1776

THE HISTORY OF THE

REPUBLIC OF THE UNITED STATES

OF AMERICA

ENTOMOLOGY



PROPOSED
PLAN AND PROGRAM
OF
EUROPEAN CORN BORER INVESTIGATIONS
BUREAU OF ENTOMOLOGY
1930*

	Pages
I - Distribution	5
II - Control	5-11
III - Seasonal Occurrence and Habits	11-14
IV - Host Plants	14-15
V - Dispersion and Economic Surveys	15-17
VI - Population Investigations	17-19
VII - Investigations in Europe	19-21
VIII - Investigations in the Orient	21
IX - Natural Enemies	21-25
X - Miscellaneous	25

Arlington, Mass.

Silver Creek, N. Y.

Sandusky, Ohio

Toledo, Ohio

Monroe, Michigan

Hyerres, France

Yokohama, Japan

* Supersedes and supplements outlines of
1919 - 1929 inclusive.

January 1, 1930.

I - Distribution in the United States.

- A - Determination of the actual distribution of P. nubilalis in the United States. (In cooperation with Plant Quarantine and Control Administration.)
 - 1 - Identification of material submitted by Mr. Worthley's field scouts, quarantine inspectors and other field workers. Includes material from miscellaneous sources. (In cooperation with U. S. National Museum.)
 - 2 - Adults reared to confirm larval determination when submitted from new, widely separated areas, or from new host plants.
 - 3 - Complete note record of first-found infestation in each township. Complete file of P. nubilalis material from each first-found infestation.

II - Control

- A - Burning infested material (in cooperation with agricultural engineers and Plant Quarantine and Control Administration).
 - 1 - By machine.
 - 2 - By farm disposal methods.
 - a - Poling, breaking, cutting, raking, etc. Involves tests with various types of rakes.
 - (1) - Effectiveness of various burning methods checked by computing percentage of living borers remaining in debris; compared to original borer population.
 - 3 - Heating and combustion tests with heat and gases derived from various sources including dry heat and steam.
 - a - Free larvae
 - (1) - Determine time period and temperature required to kill free larvae under various conditions and changes of temperature, humidity, and contact moisture. The time period objective, under practical field conditions, is about two seconds.
 - b - Larvae or pupae in cornstalks.
 - (1) - Same as A-3-a-(1).
 - c - Special tests to determine possible variation in larval mortality from burning, or steaming, in different portions of the corn plant; when subjected to sharp fluctuations of temperature or contact moisture; succulent plants compared to post-mature plants containing varying percentages of moisture; under different conditions of heat dilution caused by high winds or other causes.

B - Feeding infested material to livestock. (In cooperation with agricultural engineers and Plant Quarantine and Control Administration.)

- 1 - Direct from field; 2 - As silage; 3- Ground;
4- From cutting box; 5- From husker shredder machines.

a - Effectiveness of each method under various conditions of treated material. Also with machines adjusted for various speeds and length of cut.

- (1) - Effectiveness measured by a detailed examination of definite unit of material, the larval expectancy previously computed.

C - Plowing infested material. (In cooperation with agricultural engineers and Plant Quarantine and Control Administration.)

- 1 - Experimental studies.

a - Determination of the influences responsible for migration of larvae to soil surface when plowed under, in single generation areas.

b - Study of adult emergence from cleanly plowed fields.

- (1) - See large field cage demonstration cages under II-J-7-a-(1) and (2).

c - Critical study and comparison of effectiveness of different types and sizes of plows, operated at varying speeds and with varying adjustments, attachments and accessories. Involves tests in different soil types.

- (1) - Measure effectiveness by amount of debris left on soil surface after plowing, before fitting, after crop is planted and just prior to adult emergence.

d - Determine duration of period necessary for disintegration of cornstalks when plowed under in soils of various common types. Applies to status of old corn residues as a shelter for migrating borers when again brought to soil surface by plowing, or other cultural practices.

- 2 - Field studies.

a - Effectiveness of various plowing methods checked by computing percentage of living borers surviving in debris; compared to original borer population, in stalk and stubble fields.

D - Varietal and seasonal planting. (In cooperation with agronomists, corn breeders, soil specialists, etc.)

- 1 - Experimental studies.

a - Cooperative experimental planting projects with Bureau

of Plant Industry; Massachusetts Agricultural Experiment Station and Illinois Agricultural Experiment Station.

- (1) - Involves planting of standard varieties, hybrids and strains on successive dates.
 - (2) - Corn breeding to determine and to develop plant characteristics tolerant or resistant to severe corn borer injury.
- 2 - Field observations.
- a - Analysis of effect of seasonal planting as shown by data secured in infestation surveys of commercial fields.
- 3 - Phenological studies on the development of common trees or shrubs, to correlate plant development with the optimum time of planting corn to avoid severe injury by the insect and with the seasonal occurrence of the insect.
- E - Status of host plants other than corn. (Continued from 1929.)
- 1 - Experimental studies in the Middle West.
 - a - Experimental plats of cotton, millet, the more important sorghums, oats, barley, beets, beans, celery, potato, tomato, buckwheat, sunflower, soy bean, cowpea, alfalfa, red and crimson clover, sweet clover, dahlia, gladiolus, chrysanthemum, cosmos, geranium, golden glow, hollyhock, calendula, zinnia and the more commonly infested weeds in two-generation areas or in foreign areas of one-generation infestation. Includes Artemisia vulgaris or mugwort.
 - (1) - Determine status of each as a true food plant or as a shelter plant.
 - (2) - Study effect of isolating corn borer, in cages, on several of the more susceptible plants of the above group, plus the more susceptible weeds for a long period of years. To determine possible existence of host plant races, the effect of such isolation upon the insect, and whether such plants will support the corn borer indefinitely in the absence of corn.
 - (3) - Determine percentage of larval survival in the instance of such plants as support an infestation.
 - 2 - Experimental studies in New England.
 - a - Same as II-E-1-a, including only those plants upon which adequate information has not already been secured.
 - b - Study of plants which may be repellent or toxic to P. nubilalis.
 - 3 - Field observations.
 - a - Check results secured under II-E-1 and II-E-2 with com-

mercial plantings.

b - Study of infestation in weeds and large-stemmed grasses.

- (1) Determine status of each as a true food plant or as a shelter plant. Note distance from growing corn or infested corn remnants.

F - Disposal of infested material in manure pile, barnyard and feedlot. (Continued from 1929.)

1 - Mortality of larvae contained in corn, or in other plant remnants, when incorporated in animal manure.

a - Entire stalks; b- Portions of stalks; c- Cobs; d- Partially buried; e- Entirely buried; f- Under varying conditions of moisture; g- Under various methods of handling; h- From different animals (horses, cows, hogs, sheep).

- (1) - Experimental studies. Duplication of typical barnyard conditions with detailed study of fate of larvae in infested material, the larval expectancy of which has been computed before beginning of experiment.

- (2) - Field observations. Numerous examinations of corn remnants, and other plant material, under farm conditions, noting points detailed in II-F-1-a to h.

G - Insecticides. (Cooperation with U. S. Bureau of Chemistry and Soils; State workers, Dominion of Canada and Province of Ontario.)

1 - Experimental tests (continued from previous years).

- a - Materials - arsenicals, emulsified extracts and water solutions, oil emulsions, silico-fluorides, tobacco dusts and other nicotines, - involving carriers, emulsifiers, adhesives, colloids, etc., employed in the preparation and application of insecticidal materials.
- b - Tests of toxicity, adhesiveness, number of applications, plant tolerance, compatible combinations, costs of application for small areas and for large-scale operation.
- c - Application - plot technique and arrangement, methods, equipment, supplementary adhesives.
- d - Schedule of applications (dependent upon availability of fields) - number, with reference to seasonal development of plant and insect, and with relation to meteorological conditions.

2 - Laboratory investigations (continued from previous years).

- a - Chemical tests - exact formulae of material employed, deterioration, residues, compatible combinations, value of emulsifying agents, cause of intolerance.

- b - Biological tests - ovicidal value, larvicidal capacity.
 - c - Relation of insecticides to feeding habits - distribution of insecticide, distribution of feeding punctures, materials ingested, materials rejected, age of larva at first ingestion of plant material, physiology of digestion in first instar, importance of cannibalism in feeding habits, nature of tropic-response complex governing feeding reaction, operation of response complex in relation to presence of insecticides, relation of insecticidal agents to tunneling habit.
- 3 - Trial field tests (continued from previous year).
- a - Efficiency with respect to plant tolerance.
 - b - Efficiency with respect to cost of application.
- 4 - Commercial field tests (continued from previous year).
- a - Efficiency of method and material.
 - b - Cost of method and material.
 - c - Profit under commercial conditions.
 - d - Relation of insecticides to respiratory requirements - distribution of insecticides, source of metabolic oxygen, method of oxygen absorption, specific effect of "control insecticides."
- 5 - Collaborative insecticide program with interested State workers (continued).
- 6 - Tests of new insecticides in cooperation with U. S. Bureau of Chemistry and Soils (continued).
- H - Storage of cornstalks. (Cooperation with agricultural engineers.)
(Continued from previous programs.)
- 1 - Experimental studies.
- a - Studies upon results of storing cornstalks under various conditions of exposure to temperature, and moisture, on various dates. Determine percentage of original borer population surviving to adult stage; fecundity of such adults and percentage of larval survival of progeny.
- 2 - Field observations. Checking above, by examination of cornstalks, cobs and other corn remnants, stored under typical or special farm conditions.
- 3 - Percentage of larval survival and emergence of adults from baled cornstalks, when such stalks are stored under various conditions of exposure to moisture and temperature.
- a - Entire cornstalks.

b Shredded material.

c - Processed by other special methods.

I - Trap crops. (Continued from previous programs.)

1 - Field observations in the Middle West.

a - Check results of trap crop plantings, where a sequence of planting occurs from early to late. Analyze results of annual infestation survey and experimental plot data on same basis.

2 - Field observations in New England.

a - Same as II-I-1-a, with proper allowance for two-generation conditions.

J - Miscellaneous control projects.

1 - Comparative mortality, to adult emergence, in trash on soil surface in small area simulating various cultural conditions. (Continued.)

2 - Continuation of project to determine progressive larval population on surface of plowed fields, from early to late spring.

3 - Continuation of project to determine importance of migration of larvae from or to corn in shock.

4 - Continuation of special project upon effect of plowing early sweet corn in late summer, when stalks are green.

5 - Tests to determine relation of moisture content of infested ear corn, at time of heat treatment, to subsequent viability of seed-corn, and rate of borer mortality.

6 - Continuation of project to determine influences inducing larvae to desert plowed-under host plants.

7 - Continuation of demonstrations of comparative efficiency of common or recommended farm control practices, under screened areas approximately one-tenth acre in size.

a - Simulate farm practices to demonstrate relative percentages of survival and re-infestation when:

(1) - Entire stalks cleanly plowed under, followed by disking.

(2) - Same as 7 - a - (1) - followed by spring-tooth harrowing.

(3) - Stalks cut at ground level, followed by disking.

(4) - Six-inch stubble disked.

(5) - Entire stalks disked.

(a) - In each screened area, determine larval population before treatment, erect cage just prior to adult

emergence, dismantle cage at end of flight period, determine resultant borer population, compare cage yields and borer population with adjacent check areas, comparative meteorological records and plant development, inside and outside cage.

III - Seasonal Occurrence And Habits.

A - Seasonal occurrence.

1 - Single-generation area.

- a - Gross records of seasonal occurrence under various typical habitat conditions. Includes systematic dissections of infested cornstalks, under natural conditions, on scheduled dates, based upon velocity of development. Application of these data to field observations and field experiments.
- b - Special observations and field dissections in late summer and early autumn to determine possible development of second generation.
- c - Phenological studies as detailed under II-D-1-3.

2 - Two-generation area.

- a - Same as III-A-1-a.
- b - Special stress upon field observations to determine percentage of individuals developing a second generation.
- c - Special observations to determine districts of separation, or possible intermingling, between one generation and two-generation "strains" in that portion of New England and Long Island where the two "strains" are occupying the same or adjacent territory.
- d - Determination of the limits of the two-generation area, as indicated by summer pupation.

3 - Special studies to determine the influence contributing to the separation of the one-generation and the two-generation cycle zones.

a - In the United States.

(1) - Biological, meteorological, ecological.

b - In Europe.

(1) - Biological, meteorological, ecological.

B - Habits (Larvae)

1 - Migration. (Continued from previous programs.)

- a - From infested plant material plowed under.
- b - From or to growing plants, or plants in natural position.
- c - From or to corn in shock.
- d - From or to corn, or other plants, cut and piled.
- e - To other parts of same host.
 - (1) - Dispersion of young larvae after hatching from egg cluster.
 - (2) - Studies relative to migration of larvae to lower portion of plant during the late season, with special reference to its application to low-cutting operations.
 - (3) - Determination of conditions favorable to larval migration to ears, with special reference to sweet corn.
- f - Influence of natural or artificial barriers in preventing or limiting migration.
- g - Daily and seasonal period of maximum migration.
- h - Meteorological influences affecting migration.
- i - Migration to plants and inanimate objects for shelter.
- j - Migration, mortality and survival of newly hatched larvae.

2 - Hibernation.

- a - Continued observations relating to mortality during hibernation, under various conditions of exposure, host plants, shelter plants, and inanimate objects.
- b - Continued study of conditions affecting hibernation under controlled conditions.
- c - Meteorological conditions affecting hibernation.

3 - Mortality.

- a - During hibernation. See III - B - 2.
- b - During establishment or growth to mature larvae (survival).

(1) - Continuation and elaboration of projects to determine and measure the conditions influencing the percentage of larval survival from eggs deposited naturally by the moths, or from eggs artificially placed on corn of different types, varieties or strains, planted on varying dates on different soil types and with varying levels of soil productivity. (Cooperation with agronomists, plant breeders and soils specialists.)

(2) - In experimental plots.

(3) - In large cornfields under typical field conditions.

4 - Tropic response in larval instars.

a - Laboratory experiments - identification of tropic reactions, sequence of tropic reactions, influence of response complex phenomena on tropic reactions, measurement of repellent and attractant values in response phenomena.

b - Field experiments - relation of response to planting method, relation of response to insecticide application.

5 - Low-temperature relations.

a - In roasting-ear sweet corn (checking commercial cold storage practice) - effect of controlled abnormally low temperatures for varying periods of exposure at each stage of borer development.

b - In seed corn - exposure of hibernating larvae to low temperature for varying periods, involving the low temperature limit in hibernating larvae.

6 - Food and feeding habits.

a - Plants and parts of plants required, preferred or most suitable for food; or rejected as food; or actually found toxic.

b - Condition of plant as affecting food value, amount of food required.

c - Cannibalism.

d - See Host Plants - Section IV, also III - 4 and 5.

C - Habits (Adults).

1 - Oviposition - selection of plant species or variety, stage of development and condition, selection of parts of plant.

- 2 - Meteorological and seasonal conditions affecting oviposition.
- 3 - Biochemical cooperative investigations at the Boyce-Thompson Institute for Plant Research.
 - a - Phytochemical studies of preferred hosts - distribution of volatile substances in host plants, extraction of essential constituents.
 - b - Aliphatic and cyclic derivatives - identification of odorous principles, synthesis and preparation, classification, shipment to Arlington, Massachusetts, laboratory for testing.
 - c - Miscellaneous technical phases of testing.
- 4 - Tropic response.
 - a - Chemotropic response in adult - value of attractant substances and of repellent substances.
 - b - Relation of chemotropism to the normal response complex - identity of the chemotropic response, the response causing the induction of chemotropism, influence of a tropic reaction on the development of a chemotropic threshold.
 - c - Field investigations of attractant and repellent substances - physical state of materials, field trap experiments, attractant baits.
- 5 - Flight habits in single and in two-generation areas.
 - a - Influence of air conditions on the manner and extent of flight.
 - b - Relation of flight to emergence and oviposition.
 - c - Relation of flight to the topographic situation of cornfields and weed areas.

IV - Host Plants

- A - Continuation of complete host-plant lists and classification according to degree of susceptibility and status as a food plant or as a shelter plant.
- B - Continuation of investigations relative to stages of P. nubilalis occurring on known host plants, separation of food plants and shelter plants, suspected host plants, plants exhibiting toxic or repellent qualities.
- C - Isolation cages in two-generation area, containing preferred host plants other than corn, to determine the

accumulative effect of each host plant upon the borer, the possibility of host-plant strains of the insect, and the probable status of the tested plants as host plants of P. nubilalis in the absence of corn over extensive areas.

- D - Isolation cages in single-generation area containing common large-stemmed field crop and truck crop plants, common weeds and grass-like plants. Same objective as detailed under IV - C.
- E - Study of host plant communities, both natural and artificial, in respect to choice of host by the adult and by the larva. (New England.)
- F - Plants which may repel or inhibit the moths from depositing eggs within the sphere of their influence. (New England.)

V - Dispersion and Economic Surveys (Cooperation with Plant Quarantine and Control Administration).

Note: Data collected under this section to be analyzed under Section VI.

- A - Flight - refer to III - C - 5.
- B - Relation of artificial and common carrier to dispersion.
 - 1 - Continuation of investigations relative to transportation of all stages of P. nubilalis in commercial products.
- C - Relation of water-drift to dispersion of infested host plants or waste commercial residues (continued).
- D - Dispersion as indicated by the comparative intensity of infestation from year to year, as indicated by the following infestation surveys: (Continued.)
 - 1 - In cornfields of selected, representative townships in older portions of each infested section (New England, eastern New York, Long Island, western New York, Ohio and Michigan). Such surveys are made on the same or nearby fields or farms each year, thus providing annual comparison of data.
 - 2 - Same as above, to include the entire infested districts of each main section, inside the "zero border," on the basis of 5 cornfields per township. In the Great Lakes section these surveys include 5 representative townships per county, while in the New England section about one-third of the townships are included, following a "checkerboard" arrangement. The same townships are taken each year, thus providing annual comparisons of data.

- 3 - In sweet corn fields, just prior to harvest. (New England and Long Island.)
- 4 - In special sectional survey in cornfields of Michigan (Monroe Laboratory).
- 5 - In small home garden patches of sweet corn in cities and large villages, in selected localities of New England and Long Island.
- 6 - In field and sweet corn, in relation to seasonal planting. (An analysis of data from cornfield surveys indicated in this section) - See II - D - 2 - a.
- 7 - In economic host plants other than corn. (New England and Long Island.)
- 8 - In susceptible weed hosts. (New England and Long Island.)
- 9 - In stubble of special cornfields to determine borer population remaining in such residues, as a basis for analysis of farm clean-up or disposal practices.
- E - Classification of infested areas according to intensity and character of infestation, with special reference to comparative borer populations in corn and other host plants, including the approximate size of the area involved in each class. Applies to Great Lakes section, New England and Long Island.
- F - Special preclean-up surveys in limited localities of the main districts detailed under V - D - 1. To determine borer population before clean-up or farm disposal.
- G - Special surveys after clean-up, or farm disposal, to determine borer population surviving farm practices. Analysis and classification of resulting data to determine comparative efficiency of each practice. This survey is confined to fields indicated in preceding paragraph (V - F).
- H - See Section VI - "Population Investigations."
- I - Damage and commercial loss to corn and other crop.
 - 1 - Analyses of above surveys to compute probable economic losses involved.
 - 2 - Special study of resulting economic damage to corn by varying borer populations (cooperation with agronomists and soils specialists of U. S. Bureau Plant Industry and Ohio Agricultural Experiment Station).
 - a - Secure weights of stalks and ears of 500-plant samples of a uniform strain of Clarage planted in three areas characterized by different levels of soil productivity,

each sample containing, on the average, 0, 1, 3, 5 and 10 borers per plant, respectively.

- (1) - At Sandusky, Ohio - on very fine sandy soil.
 - (2) - East of Sandusky (Huron) - on loam soil derived from shale and sandstone formations.
 - (3) - Toledo, Ohio Demonstration Farm - on clay loam soil, derived from limestone formations.
- b - Secure weights of stalks and ears of 500-plant samples of a special dent corn hybrid, each sample containing, on the average, 0, 2, 5, 10, 20 and 30 borers per plant, respectively. To supplement data secured in 1928 concerning relation between economic loss (weight, quality and nutrients), and various levels of borer population.
- c - Damage demonstration on Toledo, Ohio farm (continued) - to supplement project indicated in preceding two paragraphs - on clay loam soil derived from limestone formations, employing a uniform strain of Clarage corn.
- (1) - Artificially infest (or restrict) each of seven 10-row blocks containing 80 hills per row, with sufficient eggs to produce an average of approximately 0, 5, 10, 15, 20, 25 and 30 mature borers per plant, per block, respectively.
 - (2) - The artificially infested blocks to be separated by blocks of equal size, containing natural infestation only, to serve as a check.
 - (3) - Adequate samples taken from each borer level and from each check, to determine comparative losses in weight, quality and nutrients of ears, grain, stalks, leaves and husks, chargeable to P. nubilalis.

VI - Population Investigations.

Explanation Of This Section: With the continued growth, and the economic importance of projects dealing with corn borer abundance (population), and its relation to possible economic loss, it has become increasingly difficult to coordinate and interpret the results from the several projects dealing with this subject. Therefore, this particular section of P. nubilalis research has as its objective the rendering available in a more concise form, essential information for immediate use, compiled from data which have been collected upon corn borer abundance, and the various influences affecting such abundance, since the beginning of corn borer research in this country and abroad.

- A - Environments will be classified to show the correlation between the following points and corn borer abundance, and to determine the effectiveness of each significant factor upon corn borer abundance:
 - 1 - Climate type.
 - a - Normal characteristic for important economic areas which correspond with varying densities of population.
 - b - Variability of significant factors and their probable occurrence.
 - 2 - Plant habitat.
 - a - Host concentration and dominance in various habitats.
 - (1) - Particular attention devoted to definition of plant habitats in New England area, or where diversity of host plants is a feature of the insect's food requirement.
 - (2) - Relationships studied between densities of population and the varying economic uses of the host plant, as applied to Middle West conditions.
 - 3 - Agricultural practice.
 - a - Particular attention devoted to the effect of leaving or removing from habitats the residue of economic hosts.
 - b - Also to the concentration of residues of non-economic hosts in the two-generation area.
 - 4 - Economy.
 - a - Value of economic crop.
 - b - Amount of funds that could be justified expendable upon control from viewpoint of possible borer abundance and consequent loss.
- B - In all distinct environments, throughout the distribution of P. nubilalis, the variations of abundance and life features will be brought to the basis of a normal for each environment and the variations from this normal determined as to their probable occurrence and correlation with events in the population of economic significance.
 - 1 - Life and seasonal history.
 - a - Particular emphasis directed to the study of intermixture of one-generation and two-generation "strains" in districts of economic importance.

- b - Normal and deviations from normal as associated with significant factors in the environment.

2 - Population fluctuations.

- a - Normal levels of population as associated with significant factors in the environment and their relation to probable damage.
- b - Probable occurrence of sharp deviations from the normal level of population and their environmental and economic significance. These classifications will be based solely upon the economic aspects of the borer population.

- (1) - Regions where outbreaks are of frequent occurrence.
- (2) - Regions where the borer population is frequently dangerous but where distinct outbreaks seldom occur.
- (3) - Regions where the borer population is only occasionally of economic significance.

- C - The hypotheses obtained from the results of the first two sections (VI - A and VI - B) will be checked experimentally in the field or laboratory.

- 1 - Possibilities of, and the amount of, flight under varying conditions.

- 2 - Association of a certain degree of damage with various levels of borer population.

- 3 - Statistical methods.

- a - Tests of significance, sampling methods, analysis.

- 4 - Field surveys and experiments.

- a - Potential source of borer population, flight, eggs, survival, resultant population.

VII - Investigations in Europe.

A - Distribution.

- 1 - Continued checking of recorded distribution in so far as this can be done when scouting for parasites.

B - Seasonal history.

- 1 - Continued collection of data in Hungary, Yugoslavia, Italy, France, Belgium.

- a - Towns will be selected over the entire region representing special environmental differences, as has been done in the past. Special collections and field studies will

be made at these points.

- b - Data will also be collected to show the transition zones between areas of one and two-generation seasonal history.

- (1) - Data will be collected in the transition zones for the purpose of studying meteorological conditions in connection with seasonal history and number of generations.

- (2) - In any area under observation particular attention will be devoted to the collection of such information as may lead to a knowledge concerning the reactions of the insect to certain distinct types of environment.

C - Abundance and damage.

- 1 - Continuation of surveys in the Danube Basin and in Italy and France, to determine abundance and economic importance of the borer. Special survey in the Po Valley.

- a - The above surveys will include the taking of data upon the main points mentioned in preceding paragraphs.

- b - Data upon infestation in economic crops other than corn.

- c - Similar observations will be made to determine the infestation in such plants as related to severely infested corn.

- d - Observations to be made upon the infestation in weeds following a similar plan, with special attention to Xanthium and Polygonum along the banks and islands of the lower Po.

D - The determination of economic and non-economic host plants.

E - See special section upon parasite investigations in Europe.

F - Natural enemies other than parasites.

- 1 - Studies will be initiated on the value of aphid lions and mites as predators on the eggs of P. nubilalis in the Jura and Artemisia regions.

G - Control

- 1 - Observations will be made (as heretofore) on the effectiveness of control practices of all sorts, such as

practices actually designed to combat the borer and auxiliary practices which exert an influence upon borer abundance; for instance, cultural practices (i.e., planting dates, disposition of stalks and stubble, varieties, etc.). This to apply to the Danube Basin, northern Italy, the Jura corn-growing region of France, and the southwestern corn-growing region of France.

VIII - Investigations in the Orient.

A - Continuation of present investigations with same general plan as outlined under "Investigations in Europe" - Section VII, when applied to Japan, Chosen, China, Manchuria, Siberia (Amur), Formosa, Philippines.

1 - Biological observations.

2 - Economic observations.

3 - Ecological observations.

4 - Parasites and other natural enemies.

a - Continuation of shipments to the United States of those species which investigation and trial liberations may demonstrate as suitable for trial.

IX - Natural Enemies.

A - Parasites (Investigations in United States.)

1 - Foreign parasites.

a - Continued importation of desirable species from Europe and the Orient.

b - Continued liberation of all parasite adults not required for laboratory breeding, at selected points throughout areas infested by P. nubilalis. Special stress upon precautions to prevent escape of hyperparasites.

c - Continued allotment of quota of imported parasite material to cooperators in Canada.

d - Continuation of large-scale breeding campaigns of all such parasite species for which a satisfactory breeding technique has been developed. Liberation of such material at points indicated under IX - A - b.

e - Continuation of investigations to develop, or perfect, the breeding technique for such parasite species not

yet satisfactorily solved, through a critical, practical study of their biology.

- f - Perfection and improvement of existing breeding methods, to increase efficiency and economy.
- g - Continuation and expansion of projects for field collections to attempt the recovery of imported parasite species, in all areas, with special reference to direction and velocity of dispersion, and percentage of host parasitized.
 - (1) - At selected points in infested districts.
 - (2) - From parasite conservation cages.
 - (3) - Includes collections of P. nubilalis and associated species.
- h - Continuation of morphological studies and of life history, seasonal occurrence, habits, host relationship, and other important biological reactions of each imported parasite species.
- i - Continuation of investigations to determine the reaction of imported parasites, particularly their survival, to common control or farm disposal practices directed against P. nubilalis.
- 2 - Native parasites.
 - a - Continuation of observations and systematic collections of P. nubilalis for rearing at selected points, and from parasite conservation cages. Includes material mentioned under IX - A - 1 - g.
 - b - Continued taxonomic and morphological studies of reared native parasite material.
 - (1) - Systematic grouping of reared individuals.
 - (2) - Study of morphological characters to aid in their identification and separation from imported species. Involves a photographic study.
 - (3) - Preparation of material for reference to group specialists.
 - c - Continuation of critical studies upon the economic status and abundance of native parasites recovered from parasite conservation cages, with due allowance for their assignment to the proper host, as determined by

isolated, individual rearings. Special attention to the comparative status of each native species from year to year, as a natural enemy of P. nubilalis.

- d - Continuation studies of native or imported parasites attacking host species associated with P. nubilalis, which parasites are, or may later become, parasitic upon P. nubilalis. To aid in the separation and identification of developmental stages of parasites found attacking P. nubilalis. Particularly important in the instance of boring insects possessing habits quite similar to those of P. nubilalis.
- e - Continuation of laboratory breeding and field collections of the native egg parasite Trichogramma evanescens Wesm.

(1) - Tests, costs and possibilities as an aid in natural control.

B - Parasites (Investigations in Europe).

1.- Continuation of large-scale shipment to America. The following species will be collected and shipped this year.

- | | |
|-----------------------------------|--------------------------------------|
| a - <u>Masicera senilis</u> | g - <u>Microgaster tibialis</u> |
| b - <u>Zenillia roseanae</u> | h - <u>Apanteles thompsonii</u> |
| c - <u>Zenillia mitis</u> | i - <u>Macrocentrus gifuensis</u> |
| d - <u>Eulimneria crassifemur</u> | j - <u>Phaeogenes nigridens</u> |
| e - <u>Inareolata punctoria</u> | k - <u>Pristomerus vulnerator</u> |
| f - <u>Chelonus inanitus</u> | l - <u>Hemiptarsenus unguicellus</u> |
- and probably other species as yet undetermined found in corn (if they prove to be parasitic on P. nubilalis).

2 - Continuation of studies on cold storage and packing technique, in relation to shipping of cocoons and parasitized larvae.

3 - Continuation studies of the abundance of all parasite species attacking the borer in each faunal zone of France, northern Italy, and the Danube Basin, in relation to the value of such parasites as controlling factors of P. nubilalis.

4 - No new areas will be scouted this year but all funds will be expended upon (see 5):

- 5 - Continued scouting for better collection points in regions previously studied in France, Italy, and the Danube Basin.
- 6 - Continued studies upon the effect of various cultural practices and meteorological conditions on the abundance of the various species of parasites in the various faunal, floral, or climatic zones of France, Italy, and the Danube Basin.
- 7 - Continued studies upon the biology and morphology of the following species of parasites, with a view to breeding in quantity those species not yet being bred and of learning how better to handle the collection, shipment, mating, and liberation of all species:
 - a - Apanteles thompsonii (almost finished)
 - b - Macrocentrus gifuensis (terminated)
 - c - Microgaster tibialis (under way)
 - d - Chelonus inanitus (well advanced)
 - e - Phaeogenes nigridens (well advanced)
 - f - Hemiptarsenus unguicellus (under way)
- C - Parasites (Investigations in the Orient).
 - 1 - General procedure indicated under VIII - A - 1 to 4 inclusive.
 - 2 - Continuation of parasite shipments according to results of investigations to determine desirable parasite species of P. nubilalis in the Orient, their biology, inter-relationships, economic status, etc., etc.
 - 3 - Procedure with parasite material from the Orient has been indicated under IX - A - 1 - a to i inclusive.
- D - Predators.
 - 1 - Insects, spiders, birds, rodents, etc.
 - a - Continuation of investigations relating to the economic status of each of the above, as natural enemies of P. nubilalis.
 - b - Special project to determine control measures, specific identity and general biology of spiders destroying parasites and P. nubilalis in parasite conservation cages.

c - Special observations upon bird activity in Providence, R. I., locality where birds were of extreme importance as predators in 1929.

E - Disease.

1 - General observations upon mortality of P. nubilalis larvae possibly attributable to disease, or disease producing organisms, in the field or in rearing cages.

X - Miscellaneous.

A - Continuation of projects relating to the collection and preservation of all stages of P. nubilalis and associated insects, together with typical samples of injury to host plants, and all parasites, for study and exhibition purposes.

B - Photographs of control operations and equipment, apparatus and experimental equipment, infested host plants and portions thereof showing typical injury, parasites and technique employed, associated insects and important points in their biology. Completion of special motion-picture project, showing all phases of parasite investigations.

C - Continued studies of biology, morphology, distribution and economic importance of insects frequently confused with, or associated with, P. nubilalis. Includes a complete investigation of natural enemies of such species.

BUREAU OF AGRICULTURAL ECONOMICS



Studies Relating to the Corn Borer (In Progress and To
Be Made) by the Bureau of Agricultural Economics

Dr. Holmes

1. The analysis of types of farming in the corn borer areas of the central and eastern Corn Belt and adjacent areas will be continued in 1930. Studies of this sort are now practically completed in Minnesota, Michigan, and Indiana. Similar studies are being undertaken in Missouri, Kentucky, and Pennsylvania.

In these districts, areas with similar systems of farming are outlined and particular attention is paid to the importance of corn on farms of different types and sizes. The factors making corn of greater or lesser importance are given special attention, particularly with reference to the modification of these conditions and influences which are likely to come about by a serious degree of corn borer infestation. The basic material and comprehensive view of the farming of these States derived from these farm type studies are being used in formulating other and more intensive types of farm management and cost studies relating to adjustment in farm practices and organizations now made necessary or impending as a result of the corn borer.

2. A study of farm practice and equipment and power used in corn production has been pursued during the past year in Indiana in an area which is only now being infested and in which corn is so important an enterprise that a considerable portion of it is husked from the standing stalks. In this area, corn borer control will be a more serious problem, and incur much heavier costs above those now involved in present methods of production, than the areas now infested. The figures we obtain from this area form a basis for study and experimentation on revised crop rotations and revised operations in the production of corn as well as in its utilization. Field work on this project will continue during 1930 and, in addition, the working out of rotations and systems of operation will be undertaken with a view of seeking to have them tried out under actual farm conditions by farmers where infestation seems to be imminent.

In addition to the above-mentioned project, a similar one is being established for operation during 1930 and subsequent years in southeastern Michigan where infestation is already serious and where the type of farming is rather distinctly different from that in the Indiana area. All of this work is being prosecuted with the State Experiment Stations.

3. In connection with the projects listed under "2" above, special attention is to be paid to the use of machines and equipment and the demonstration so far as possible under actual farming conditions of machines and equipment being developed by agricultural engineering agencies.

4. A study to determine the conditions under which it will be advantageous for farmers to substitute other crops for all or a part of their corn acreage. In this connection the following factors are being considered: (1) possible damage by the borer and reduction in the yield of corn (2) increased labor and power for growing corn under corn borer conditions (3) possible reduction in yields of other crops because of delayed seeding or changes in methods of preparing the land and (4) relative returns for corn and other crops. This includes a study of the outlook for such crops as sugar beets, canning crops, soy beans, alfalfa and other feed crops, and the way they would fit into present cropping systems. The experience of farmers in Ontario, Canada, in increasing the acreage of tobacco, sugar beets and canning crops due to the reduced corn acreage on account of the corn borer will be considered in connection with this study.

ANIMAL INDUSTRY



BUREAU OF ANIMAL INDUSTRY, ANIMAL HUSBANDRY DIVISION

A Study of Adjustments in Livestock Production Practices - made necessary by the advent of the European Corn Borer.

A - Studies on investigations to date and results accomplished.

1. Studies of the husker-shredder requirements and utilization of shredded stover in livestock production have been conducted in cooperation with the Bureau of Plant Industry and Agricultural Economics and the State experiment stations of Michigan, Ohio, and Illinois. The essential information resulting from this study is presented in Farmers' Bulletin 1539, "The Husker-Shredder on Eastern Corn Belt Farms."
2. In cooperation with the Bureau of Plant Industry, studies are being made on the uses of pasture crops in livestock production to effect the reduction of corn requirements in relation to economy of production and quality of products. In 1929 three lots of steers were grazed at the Animal Husbandry Experiment Farm, Beltsville, Maryland. Lot 1 consisting of 4 steers grazed continuously at the rate of two acres per head; lot 2 included 5 steers which grazed continuously at the rate of one acre per head; and lot 3, which was made up of 4 steers, grazed at the rate of one acre per head. The pasture for lot 3 was divided into two equal areas and the cattle rotated at the end of each two weeks period. Additional tests are necessary for conclusive results.
3. An economic study of beef cattle production has been conducted in cooperation with the Bureau of Agricultural Economics and the State experiment stations of Virginia and West Virginia. The purpose of this study was to obtain specific information on prevailing methods for raising and handling cattle to meet market requirements with a maximum of pasture and a minimum of corn consistent with satisfactory returns to the producer. The field work for this project has been completed, much of the data is tabulated and the manuscript reporting the results is now being prepared.
4. Through cooperation with the Bureau of Entomology, this bureau obtained representative samples of infested corn plants from six different plots, each with a known intensity of infestation. The minimum intensity was approximately 5 borers per stalk and the maximum was approximately 30. The chemical composition of the kernels, cobs, husks, leaves, and stripped stalks from each plot is being determined.

3 - Investigations under way and proposed under this project:

1. Determination of the value of borer-infested corn plants when fed in different forms (viz., silage, cured fodder and stover) for growing, for fattening, and for the maintenance of the different classes of farm animals.
2. A study of the greater use of pasture crops in cattle and sheep production to effect a reduction in the corn requirement.
3. An economic study of beef production, involving the use of supplemental feeds on pasture.
4. The effects of control measures now used in combating the corn borer on the economy of swine production.
5. The effects of decreased corn production with reference to substitute grains and greater use of pasture crops.
6. The effect of control measures on change in type and market weight of hogs.
7. The effects of changed feeds on the quality and desirability of meat produced.

BUREAU *of* CHEMISTRY AND SOILS



BUREAU OF CHEMISTRY AND SOILS

INSECTICIDES

1. Chemical analyses of insecticides used by the Bureau of Entomology in its various laboratory and field tests.

2. The determination of the solubility, rate of solution, crystal size, apparent density, and other physical properties of insecticides being tested by the Bureau of Entomology.

3. The synthesis of new insecticides to be tested by the Bureau of Entomology.

SOILS

1. Utilization of cornstalks.

(a) - A survey-evaluation of the more promising uses, with especial reference to those that have received comparatively little attention heretofore, not neglecting, however, to keep in close touch with the progress of work on utilization for building and insulation board, paper, and cellulose.

(b) - Reevaluation of the fertilizer value of cornstalks to the farmer.

(c) - Compilation of data on the feeding value of cornstalks.

BUREAU *of* PLANT INDUSTRY



BUREAU OF PLANT INDUSTRY

AGRONOMIC RESEARCH, CEREAL CROPS AND DISEASES

Pickney
A. Investigations in heavily infested areas. (Cooperative with the Bureau of Entomology and the Ohio Agricultural Experiment Station. Calendar year 1930).

1. Varietal trials, combined with rate and date of planting.

- a. Oakharbor. Experiments on the effects of different rates of planting made on different dates with varieties requiring different periods to mature, on the yield and quality of the crop, on the rate of growth and development, and on the number of eggs laid, the percentages of larval establishment, of infestation, and of broken stalks.
- b. Wooster, Paulding County, and Hamilton County. Duplicates of the experiments near Oakharbor except for modifications in the varieties and rates used and for the absence of entomological data because of noninfestation.

2. Fertility and retardation experiments.

Experiments on the effect on yield and quality of crop and on infestation by the European corn borer of differences in the rate and mode of development of the plants as influenced by cultural practices and by the application of fertilizers and growth-retarding substances.

- a. Oakharbor. (Productive soil). A comparison of (1) listing (2) applying various carbohydrates to retard early development and (3) clipping back the corn plants at different stages of development. The effect of the treatments will be studied, both with and without delayed supplementary application of fertilizers designed to hasten development after the maximum moth flight is over.
- b. Oakharbor. (Unproductive soil). A comparison of fertilizer applications at various rates in the hill and broadcast, with and without manure, and on listed and level planted corn.
- c. Wooster. Experiments on the effect of applying fertilizers and retarding agencies to corn on yield and development. Comparisons of different sources of nitrogen for fertilizing corn. Studies of the relative response of different varieties and particularly different hybrids between self-fertilized lines to different levels of soil productivity.

3. Corn breeding experiments.

The corn breeding experiments will comprise the continued selection of breeding stocks and the testing of these stocks for yield and resistance to borer attack, and intensive studies of the relation of these to rate of growth and physiology of development.

- a. Oakharbor. Comparing stocks for yield and for their possible resistance or tolerance to, or escapement from, borer attack. Detailed morphologic and physiologic studies of the different stocks.
- b. Columbus and Wooster. Maintaining and selecting breeding stocks and comparisons of their productiveness, quality, etc.

4. Physiologic experiments.

Studies on the rate and mode of growth of corn plants as influenced by differences in heredity and environment, and as related to yield and quality of crop and to moth preference, larval establishment, and final damage by the European corn borer. These experiments will be conducted largely near Oakharbor but will be supplemented at Wooster and elsewhere as may be desirable. The material will consist of corn plants from the various breeding experiments and from the comparisons of different rates and dates of planting, cultural practices, fertilizer applications, etc. In general, the records of the breeding stocks, treatments, etc., and of the environment as obtained by measurements of temperature, humidity, rainfall, evaporation, wind velocity, sunshine, and soil moisture will form the causal background of variation.

The effects of this variation will be investigated through:

- a. Biochemical studies of the aromatic constituents of the leaves and studies of the invisible radiant energy from the plant, as possibly related to attractiveness to the corn borer moths.
- b. Determination of the growth rate during short periods.
- c. The determination of the time required to reach certain stages of development.
- d. Studies of the gross and minute structure of corn plants with special reference to variations in the vascular system, the pith and the cortex.
- e. The determination of chemical differences in plant parts with special reference to the chlorophyll content, elaboration and transformation of carbohydrates (particularly to lignification), the mineral constituents, and the carbohydrate-nitrogen relations with particular reference to their relation to the life history and development of the corn plant.

- B. Investigations in lightly or noninfested areas. (Cooperative with the Iowa, Nebraska, Kansas, and Missouri State Agricultural Experiment Stations, calendar year 1930).
1. Varietal trials, combined with rate and date of planting and cultural and fertilizer experiments to determine the possibility of modifying present practices with the advent of the borer
 2. Breeding experiments to develop corn that will be productive when planted at an abnormal time.

BUREAU OF PLANT INDUSTRY

AGRONOMIC RESEARCH, FORAGE CROPS AND DISEASES

Investigations carried on under the appropriation for;

SPECIAL EUROPEAN CORN BORER RESEARCH

Appropriation - \$30,000.

Activities

Two main lines of work have been established:

- (1) A study of the oil and protein content of soy beans in an attempt to select soy beans which shall be on the one hand higher in oil and protein content than the varieties we now have, and on the other, lower in oil content, in order to make them more suitable for hogging off. (Co-operation with Ohio Experiment Station.)
- (2) Pasture Investigations. These investigations include a study of the best methods of preparing, maintaining, and utilizing a pasture in the areas in which the corn borer has already been found or in closely adjacent areas. One such field has been laid out at Beltsville, Maryland, in cooperation with the Bureau of Animal Industry and the Bureau of Dairy Industry; another in Pennsylvania, in cooperation with the Pennsylvania State College of Agriculture, and a third at Augusta, Michigan, near Battle Creek, in cooperation with the Michigan State College.

While the details of the plans under which the work is being carried on differ in some respects, the general idea at all these places is to study the most satisfactory mixtures for seeding the pasture, the best way to fertilize, the value of mowing and other

treatments, and the yielding capacity as measured by increased weight of animals or yield of milk. At each station the details of the work are in charge of a competent agronomist.

BUREAU *of* PUBLIC ROADS



CORN BORER CONTROL PROGRAM FOR THE FISCAL YEAR
1931

Bureau of Public Roads
Division of Agricultural Engineering

Cooperation will be given in both the Eastern and Western areas with the Bureau of Entomology and Plant Quarantine & Control Administration in all control projects involving the use and development of farm and other machinery. Certain of the machines and operations are listed below:

I. Heat treatment.

A. Burners.

- a. Checking of certain results obtained in 1929 on fundamental data for burner development. This includes the tolerance to dry heat of free larvae and larvae in stalks, resistance to sudden temperature changes, and effect of gases of combustion.
- b. Continuation of the study of nozzles; i.e., design and testing.
- c. Further development and testing of the pulled-type burner. This implies improvement in design and involves the selection of low-pressure nozzles, better air distribution, increasing sturdiness of design, and more efficient use of the generated heat as by the extension of the hood to produce a lower end temperature - 300° to 500° F. Fewer nozzles might thereby be used and more efficient operation secured. Better combustion might be secured by the use of baffle plates. Consideration should be given to possible heat insulation. The most effective height for hoods should be determined. This might be accomplished by making the top hood plates adjustable for height.
- d. Refractory type generator study.
- e. Development of regenerative type burners.
- f. Incinerator development - including a type designed to receive stalks cut off by the stalk shaver.

B. Steam.

- a. Continue securing fundamental data for mobile steamer development.

(1) Use of saturated steam.

- (2) Use of superheated steam.
- (3) Use of humidified wind.
- (4) Use of humidified gases of combustion. (Exhaust or flue gases.)

b. Continuation of work on the development and testing of a low-pressure (up to 100 lbs. gauge) mobile steamer.

c. Studies of steaming methods - field, stalk pile and barnyard.

C. Costs of sterilizing with burner flame and with steam.

II. Crop remnant handling.

A. Stalk shaving - methods and costs.

a. Present design of sled-type stalk shaver.

b. Present design of wheel-type stalk shaver.

c. Development of disc-type stalk shaver.

d. Development of other types.

B. Raking - methods and costs.

a. Continued development of side-delivery rake - this includes consideration of power drive.

b. Dump rakes.

c. Wooden rakes (flop-over or rotating)
(a, b, and c, in cooperation with rake manufacturers).

d. Other types.

C. Stalk pick-up machine - design and testing.

a. Cylinder type.

b. Gearless or crank type.

c. Other types.
(Designed for use with field baler, incinerator, or wagon.)

D. Baling - whole and shredded stalks.

a. To determine keeping properties.

(1) With different moisture contents.

(2) With different conditions of storage.

b. Effect of different baling pressures.

- (1) On keeping properties.
- (2) On borer mortality.

(This involves working out a scheme for determining pressure in bales, also includes dissecting bales after moth flight to determine borer mortality and condition of baled material.)

E. Stalk beating machine development and testing.

(This has for its purpose the beating of weathered stalks in the field to kill the contained borers.)

F. Development of other machines for treating weathered stalks.

G. Determination of cost of shaving, raking, and burning.

III. Soil Working.

A. Continuation of studies on trash coverage as affected by:

- a. Different types of plow bottoms - determining the proper type for each general soil type, or section of the Corn Belt.
- b. Speed of tractor.
- c. Plow width - and selection for different soil types.
- d. Attachments - special attention being paid to the development of devices for effecting good coverage.

B. Continuation of studies on draft of plows.

C. Studies to determine best use of machines in the farmers' hands; and if possible formulate recommendations whereby a farmer can make effective use of his present equipment.

D. Cooperative studies according to A, B, and C.

- a. Continuation of work with Illinois.
- b. Initiation of work with Kentucky.
- c. Initiation of work with Missouri.

E. Further comparative studies on effectiveness of spring and fall plowing.

F. Determination of costs of clean plowing.

*G. Comparative effect on power requirements and crop yields of various soil surface treatments of corn stalk fields.

- a. Typical plowing-under of stalks followed by the regular practice of seed bed preparations.
- b. Clean plowing.
- c. Subsoiling alone.
- d. Subsoiling and discing.
- e. Discing alone.
- f. Planting (if possible) without any treatment.
- g. Removing all stalks (shaving and raking).
 - 1. Plowing.
 - 2. Subsoiling.
 - 3. Subsoiling and discing.
 - 4. Discing alone.
 - 5. No treatment.
- h. Burning stalks by field burner.
 - 1. Same as g.
- i. Steaming stalk field.
 - 1. Same as g.
- j. Soil building program tending toward better covering by securing a better tilth.
- k. Other treatments.

IV. Harvesting and Processing.

A. Development and use of attachments.

- a. Follow use of corn binder stationary knife low-cutting attachment.
 - 1. Study of blade material including effect of stelliting edge.
- b. Stalk crusher attachment for single and double row corn pickers.

(*) To be carried on at Government farm near Toledo in cooperation with other Bureaus and extending over a period of years.

- c. Cooperation with manufacturers in the development and testing of other stalk mutilating attachments for pickers.
- d. Follow development of ensilage cutters both stationary and portable.
- e. Follow development of husker shredders.
- f. Follow development of low-cutting hand devices.
- B. By-product utilization machinery. (May be carried on in cooperation with a processing company or State Experiment Station.)

V. Methods of applying insecticide.

- A. Development and use of:
 - a. Compressed air sprayers.
 - b. Rotary fan dusters.
 - c. Bellows dusters.
 - d. Power sprayers and dusters.

(Extent of this work will depend upon the requirements of the Bureau of Entomology.)

VI. Miscellaneous.

- A. Use of corn driers: - to permit picking the corn possibly a couple of weeks earlier and giving more time for clean-up work in the fall.
- B. Use of grain combine.

ILLINOIS



ILLINOIS PROGRAM OF RESEARCH ON THE EUROPEAN CORN BORER

ENTOMOLOGICAL RESEARCH

1930

I - Distribution.

A - Scouting of the eastern counties of Illinois and other areas in the State which seem most likely to become infested by the European Corn Borer. This to be carried out by the Federal Bureau of Entomology and the Illinois State Department of Agriculture. All material found suspected of being the European Corn Borer will be sent in to the Federal Laboratory or to the entomologists of the Natural History Survey for identification.

B - Through circulars, articles in the press, radio, and the Extension Department, urging individuals to send any insects suspected of being the European Corn Borer to Urbana for identification. In case there is any doubt regarding any material sent in, it will be promptly submitted to the entomologists of the U. S. National Museum at Washington.

II - The Effect on Infestation of Corn of Time of Planting. The Degree of Infestation of Different Varieties. Work to be carried out in cooperation with the agronomists at the Illinois plots in Ohio.

A - Complete data on the corn borer infestation in these plots will be taken, these data to include height of corn at the time of moth flight, number of eggs deposited on different plantings and varieties, larval establishment, results of infestation as they affect the vigor of the plant, the production of ears, the yield, the condition of the plant at time of harvest (whether broken or erect), the quality of the corn. These will be extended if funds permit.

B - Certain strains and varieties of corn which have shown resistance to, or tolerance of, infestation will be further tested under artificial infestation.

III - Studies of Host Plants Other Than Corn. These studies to be carried on in cooperation with the Federal entomologists on the Illinois plots in Ohio.

A - As these plots are to be run on a regular three year rotation of corn, soy beans and wheat, with sweet clover in the wheat, special studies will be made of the degree of infestation in all crops used in the rotation; of the weeds in and about the field, or small rows of some special crops.

IV - Habits of the Corn Borer. Some incidental work along this line will be carried on in the Ohio plots. This may include experiments with light traps and bait traps.

V - Natural Enemies.

A - Studies of the amount of parasitism of all stages of the corn borer will be carried on in the Ohio plots.

B - Special studies are now being carried on at Urbana to determine the possibility of rearing large numbers of Trichogramma evanescens Wesm. This work will be planned along several lines to determine:

- a - The possibility of rearing large numbers of T. evanescens in the laboratory.
- b - The possibility of increasing the population of this egg parasite in different parts of this State, especially by liberating large numbers of adult parasites in the spring.
- c - The effect of such liberation on the numbers of this parasite in a locality from one year to another.
- d - The effect on the native insect fauna of the locality. This parasite is such a general feeder that increasing its numbers by artificial propagation may tend to decrease the numbers of desirable insects within a region.

C - Continuation of the studies of parasites of our native Smartweed Borer and other species closely related to the European Corn Borer.

VI - General Studies of Insect Infestations in the Variety, Cultural, and Soil Fertility Plots in Illinois.

VII - General Studies of the Effect on Native Insects of the Cultural Practices Recommended for Corn Borer Control.

AGRONOMIC RESEARCH

1930

I - Tests of Varieties of Corn.

A - Grow in comparative yield tests, on cooperative plots in Ohio, approximately 20 varieties and strains of corn that have either attained prominence in Illinois or bid fair to do so. These experiments are to be conducted in cooperation with the Federal entomologists and Dr. J. R. Holbert, of the Federal Bureau of Plant Industry.

B - Determine the yielding ability and quality of grain produced under Illinois conditions of approximately 75 varieties of corn, many of which are early sorts. These studies are to be made at DeKalb in northern Illinois and at Urbana in central Illinois.

II - Time of Planting Varieties of Corn.

- A - Plant a large number of varieties of corn late to determine their comparative ability to produce a good quality of grain when so handled. This is done both at DeKalb and at Urbana.

III - Date of Planting Corn.

- A - Plant short season varieties of corn, and one standard variety as a check, at rates ranging from 1 to 6 stalks per hill to determine the rate of planting which will give maximum yields.

IV - Substitute Crops.

- A - Study the adaptation of different varieties of barley to the various sections of the State with the idea that this crop may prove a partial substitute for corn when the borer becomes serious.

V - Studies on Inbred Strains and Hybrids.

- A - Grow existing lines and hybrids of corn planted at early and late dates to determine comparative rapidity of development as indicated by dates of silking and maturity.
- B - Grow short season varieties of corn for the purpose of developing early maturing inbred strains.

VI - The Influence of Soil Treatment Practices on the Yield and Maturity of Late Planted Corn.

- A - Plant late a number of varieties of corn including a standard variety, on land receiving various kinds of soil treatment and determine the influence of the treatment on:

- 1 - Total yield.
- 2 - Quality of yield.
- 3 - Moisture content at husking time.

- B - On new land:

During the coming season plots will be laid out on new land for the purpose of enlarging the field experiments having a bearing on corn borer control. These experiments will be planned to obtain information along three lines, viz.:

1. The influence of crop rotations and soil treatment combinations on the yield and maturity of late planted corn.

2. The influence of the rate and methods of applying fertilizers for yield and maturity of late planted varieties.
3. The influence of crop residue used in various ways on the yield and maturity of late planted varieties.

ILLINOIS PROGRAM OF RESEARCH ON THE EUROPEAN CORN BORER

Agricultural Engineering Research
1930

I - Further Coverage Studies.

- A - Carry on work similar to that done in 1928 and 1929, plowing under cornstalks with different types and sizes of plows, and with different treatments of the ground previous to plowing.
- B - Make a further study of use of solid trash pans, particularly on the smaller sizes of plows now used by farmers, and on the Pulverator.
- C - Compare spring and fall plowing of cornstalks as regards the tendency of stalks to work to the surface after plowing.

II - Control Methods to be Used where Complete Coverage of Cornstalks and Debris is Not Practical.

A - In connection with corn harvesting:

- 1 - Shredding or cutting attachments to be added to corn pickers.
- 2 - Machines that pick the corn and harvest the stalks for industrial purposes.

B - After the corn is picked:

- 1 - Breaking or shoving, raking and burning.
- 2 - Machines for harvesting the stalks for industrial purposes.

INDIANA



Prof Davis

PROPOSED PLAN AND PROGRAM
OF
EUROPEAN CORN BORER INVESTIGATIONS
PURDUE UNIVERSITY AGRICULTURAL EXPERIMENT STATION
LAFAYETTE, INDIANA
1930
ENTOMOLOGY

A - Behavior Studies with Adult Moths.

- 1 - Relation of tropic responses to normal behavior of adults.
- 2 - Chemotropic Studies.

a - Production of chemical attractants from favorite host plants.

- (1) Distillates.
- (2) Extractions.
- (3) Fermentation products.

b - Testing of chemicals as attractants.

- (1) Laboratory olfactometer tests.
- (2) Field tests with bait traps.
 - (a) Number of adults attracted.
 - (b) Sex of adults attracted.
 - (c) Physiological condition of adults attracted, (gravid, spent, etc.)
 - (d) Position of baits in field, height, etc.

(3) Practical application of attractants.

- (a) Effectiveness.
- (b) Cost, etc.

c - Trap Crops. (Based on behavior studies.) *Required material*

d - Testing of chemicals as repellents.

- (1) Laboratory olfactometer tests.
- (2) Production of dust or other carriers or repellent.
- (3) Field tests.
 - (a) Toxicity to various stages in life of borer.
 - (b) Plant tolerance.
 - (c) Number of applications.
 - (d) Time of application.
 - (e) Retention of repellent capacity.
 - (f) Adhesiveness.

3. Phototropic Studies.

a - Response to natural light.

b - Response to artificial light.

(1) Lights of various colors.

(2) Kind of light.

(3) Intensity of light.

(4) Practical use.

(a) Number of moths attracted.

(b) Sex of moths taken.

(c) Condition of females (gravid, spent, etc.).

4 - Thermotropic Studies.

a - Effect on presence of moths in corn field and the movement of moths from sources of infestation.

b - Effect on oviposition.

c - Effect on response to other tropisms, as chemotropism and phototropism.

5 - Hygrotropic Studies.

a - Effect on response of moths to other tropisms, as chemotropism and phototropism.

6 - Anemotropic Studies.

a - Effect of air current and especially wind velocity on other tropisms, as chemotropism and phototropism.

B - Behavior Studies with Larvae.

1 - Young larvae.

a - Hatching

b - Establishment.

c - Degree of leaf feeding and governing factors.

d - (1) Temperature.

(2) Moisture supply, rainfall, and humidity.

(3) Wind velocity.

(4) Parasites, predators, etc.

2 - Full-grown larvae.

a - Migration from stalk to stalk in field.

b - Migration downward toward ground as season advances.

(1) Percentage left in stubble at different heights.

(2) Percentage left in stubble when corn is cut at different dates.

C - Insecticides (Contact and Repellent).

1 - Experimental tests.

a - Laboratory preparation.

b - Small field plot tests.

- (1) Toxicity to different stages of insect.
- (2) Plant tolerance.
- (3) Number of applications.
- (4) Time of application.
- (5) Retention of lethal capacity.
- (6) Adhesiveness.

c - Types of insecticides.

(1) Contact.

(a) Oils.

(b) Alkaloid poisons as liquid and dust.

(2) Repellent.

(a) Materials based on behavior studies.

d - Carriers.

e - Adhesives.

2 - Field Tests.

a - Effectiveness.

b - Cost and practicableness.

D - Seasonal Development Studies.

To be made in Indiana and to include the following:

1. Pupation.
2. Emergence of adults.
3. Oviposition.
4. Larval development.

AGRICULTURAL ENGINEERING

A - Soil working.

To find relative effectiveness of covering cornstalks, stubble and other crop remnants by:

1 - Different widths of plows.

a - As effected by various depths of plowing.

b - Various attachments for plows.

- (1)- Shields which will cause the stalks to be placed in the bottom of the furrow.
- (2)- Different types of coulters and jointers.

- 2 - Test the above as effected by previous treatment as discing (single-double), poling, rolling, culti-packing, etc.
- B - Crop remnant cleaning.
 - 1 - Detaching stalks.
 - a - Poling.
 - b - Mowing.
 1. Standard machine.
 2. Special cutter bar using special guards and knife.
 - 2 - Collecting stalks.
 - a - Dump rakes with attachments and changes.
 - b - Buck or finger rake.
- C - Field machinery.
 - 1.- Stalk Cutter--To study the possibilities of cutting standing stalks fine enough to enable complete coverage by plowing and determine possibilities of obtaining corn borer control by this method without plowing.

AGRONOMY

- A - Variety and date of planting tests.

At several locations about 30 varieties planted at four dates at two-week intervals beginning at the normal date. These varieties range from very early to late.

 - 1 - Determine comparative yields and quality of grain of the varieties and their adaptability to late planting.
 - 2 - Study characters of the varieties which may render them resistant or tolerant to attack by the corn borer.
 - 3 - Study infestation and damage from corn borer attack (in cooperation with the Department of Entomology).
- B - Rate of planting tests. Using a standard and an early variety at each location and various distances between hills and various numbers of stalks per hill.
 - 1 - Determine the optimum rate of planting for both early and standard varieties considering both yield and size of ears.
 - 2 - Learn the effect of rate of planting on infestation and damage from the corn borer (in cooperation with the Department of Entomology).

C - Fertilizer tests. Plant an early variety late and fertilize with (a) different formulas, (b) different amounts, and (c) at different times.

1 - Study the effects on yield and quality of grain.

2 - Note the effect on infestation and damage from the corn borer (in cooperation with the Department of Entomology).

D - Disposal of corn stalks. Dispose of corn stalks in various ways.

1 - Find the effects on the yields and quality of the crops under various methods of disposal.

FARM MANAGEMENT

A cooperative project with the U. S. Bureau of Agricultural Economics, entitled "A Study of Adjustments of Farm Organization and Management and of the Complete Utilization of the Corn Crop as Related to the Corn Borer." Object of the project, to determine:

- 1 - The most successful systems of farm organization and management, and the utilization of the entire corn crop as an effective means of controlling the European corn borer;
- 2 - The extent to which different methods of corn stalk utilization and disposal are now being practiced under different conditions;
- 3 - Changes that should be made in crop rotations, livestock combinations, type of equipment, and farm practices, in order to better utilize corn stalks in ways that will give greater financial returns, economically conserve soil fertility, and most effectively control the European corn borer.

MICHIGAN



MICHIGAN
EUROPEAN CORN BORER RESEARCH PROGRAM

ENTOMOLOGY

Life History.

Egg.

Deposition.

Hatching.

Larva.

Development.

Survival.

Migration.

Infestation Studies.

Corn and stubble.

Variety tests.

Date, rate, and space planting.

Date of Harvest.

Fertilizer, Topping.

Parasites and Predators.

Miscellaneous.

AGRICULTURAL ENGINEERING

We have done and are doing some work on the following projects in connection with the corn borer in agricultural engineering. Funds have not been permitted us to do any extensive work.

1. Plowing.
2. Hand methods of control.
3. Low cutting in cooperation with the Corn Borer Office, Toledo.
4. Use of "T" rail and leveling devices.

AGRONOMY

Varietal tests.

Breeding project.

Date, rate and space planting.

Date of harvest.

Fertilizer project.

Topping project.

Plowing.

Physiological and chemical studies of corn plant.

FARM MANAGEMENT

1. A study of the changes in farming practices and farm organization in Southeastern Michigan on account of the European Corn Borer. In 1927, in four different areas, 250 farmers were visited and information obtained in regard to changes in corn acreages and numbers of livestock; in regard to changes in farm practices in preparing corn

land for succeeding crops; and extra time required in the clean-up operations. This project will undoubtedly be carried on again this year.

2. Farm organization studies in the corn borer area are being arranged for the coming year. These studies to serve as a guide in determining the most successful kind of farm organization in these areas.

NEW HAMPSHIRE



NEW HAMPSHIRE
EUROPEAN CORN BORER RESEARCH PROGRAM
ENTOMOLOGY

Life history studies.

Relative preponderance and mortality of the one-generation and

the two-generation phase under New Hampshire conditions.

Parasite studies.

Host plant studies.

NEW YORK



CORN BORER INVESTIGATIONS IN NEW YORK

Agricultural Experiment Station, Geneva, N. Y., 1930.

I . Distribution.

Determination of the distribution of the pest in New York.

II Control.

- a. Plowing-under infested corn stalks and weeds, etc.
- b. The relation of the date of planting to the rate of infestation.
- c. The varietal susceptibility of sweet corn to attacks by the borer.
- d. Study of various insecticides with respect to the toxicity to the young caterpillars and the tolerance to the corn plant.

*in sweet corn
to different degrees
early planting
more months*

III Life history, habits, and seasonal occurrence of the corn borer with special reference to the protection of sweet corn in the Western area of the State.

a. Life history of:

- 1 pupa
- 2 adult
- 3 egg
- 4 larva

*early sweet corn, followed by
late planting on community basis
your co-operation control.*

b. Habits (larva).

1 Migration.

- (a) From corn stalks buried by plowing to the depth of 5, 7, and 9 inches.
- (b) From corn stalks buried during fall and spring.
- (c) From buried corn stalks adjacent to standing corn and weeds, debris and various objects capable of affording shelter.
- (d) Mortality of caterpillars during migration.

*Western N.Y. main problem preventing
entry to sweet corn.*

2 Hibernation

- (a) In corn and other plants and objects.
- (b) Mortality of caterpillars under normal conditions in corn stalks and weeds.
- (c) Mortality of caterpillars in buried corn stalks and weeds.

c. Adults.

- 1 Oviposition with special reference to early sweet corn.
- 2 Influence of meteorological conditions on egg laying.

IV Host plants.

List all host plants, indicating relative susceptibility.

V Natural enemies.

- a. Systematic collection of species to determine relative importance.
- b. Rearing parasites and introducing into infested sweet corn areas.

OHIO



THE EUROPEAN CORN BORER PROGRAM
1930

Departments of Entomology and Agronomy

of

The Ohio Agricultural Experiment Station

A. The corn borer.

1. Ecology. Further analysis of factors now known to influence borer populations. Particular emphasis will be put on the influence of nutrition. That other factors will be definitely disassociated from those already demonstrated is more than an assumption.
2. Physiology. Determination of free and bound water in larval stages.
3. Tropisms. An attempt to definitely measure certain tropisms.

B. The corn plant.

1. Physiological, biochemical, and morphological studies.
2. Corn development with reference to variety, date of planting, etc.
3. Corn breeding.

C. Empirical experiments with special reference to the relationship of borer population and corn behavior. This is the common point of contact between entomological and agronomical investigations.

PENNSYLVANIA



CORN BORER RESEARCH - PENNSYLVANIA STATE COLLEGE - 1930

ENTOMOLOGY

1. Life history and seasonal occurrence in central Pennsylvania.
(Third year.)
2. Cost versus efficiency in corn borer clean-up. In cooperation with the Dep't. of Farm Machinery and the College Farms. (Third year.)
3. Insecticides against eggs and young larvae. Possible continuation of laboratory studies begun in 1928, supplemented by field plot trials.

One born. Laid 983 eggs at
Perryman on 11/10

JOINT COMMITTEE ON THE EUROPEAN CORN BORER



APPOINTED BY
AMERICAN FARM ECONOMIC
ASSOCIATION

AMERICAN ASSOCIATION
OF ECONOMIC ENTOMOLOGISTS

AMERICAN SOCIETY OF
AGRONOMY

AMERICAN SOCIETY OF
AGRICULTURAL ENGINEERS
AND

AMERICAN SOCIETY OF
ANIMAL PRODUCTION

REPORT OF JOINT COMMITTEE ON THE EUROPEAN CORN BORER,

Appointed by

AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS,

AMERICAN SOCIETY OF AGRONOMY,

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS,

AMERICAN FARM ECONOMIC ASSOCIATION, and

AMERICAN SOCIETY OF ANIMAL PRODUCTION.

(1929)

REPORT OF THE JOINT COMMITTEE ON EUROPEAN CORN BORER

TOLEDO, OHIO, SEPTEMBER 27, 1929.

The European corn borer has continued its natural spread since its discovery in America in 1917. Its average rate of advance to the South and West has been from 25 to 30 miles per year. In 1929 it occupied 10,000 to 12,000 square miles of new territory in the United States. It now occurs throughout the southern portion of Quebec and Ontario, as well as locally in New Brunswick and Nova Scotia in Canada, the southern two-thirds of New England, the northern extremity of New Jersey, all of New York, three-fourths of Pennsylvania and Ohio, the Panhandle of West Virginia, nearly all of the agricultural portion of Michigan and the northeastern fourth of Indiana. It has now reached the threshold of the main Corn Belt.

The corn borer is only thinly distributed over the newly infested territory and causes no apparent injury. It increases in numbers rather slowly at first and, judging from past experience, will not cause evident injury in the first 2 to 4 years. This provides a period during which the entire community should obtain and apply the latest recommended control measures. In most of the older infested areas the borer has increased greatly in numbers. Where this insect has been established for several years, commercial damage to corn now occurs unless natural factors have checked the borer temporarily or adequate control measures have been applied. If this is true in the eastern edge of the Corn Belt, where most of the corn is cut and much of it put in the silo, thus simplifying an adequate clean-up, how much more will it be true in the main Corn Belt where most of the stalks are left in the field?

It, therefore, is still the opinion of the Joint Committee that, unless the corn borer is controlled, it will become one of the most destructive crop pests ever introduced into America. The situation, presenting, as it does, the possibility of enormous agricultural losses, calls for the continued cooperation of the farmer, the scientist, the educator, and all State and Federal administrative officials.

The cooperating committee of entomologists, agronomists, agricultural engineers, agricultural economists, and animal husbandmen, most heartily endorses all endeavors to control the corn borer, and commends the efforts of all farmers practicing control measures and all persons engaged in the research, regulatory, and educational activities.

1. The first part of the paper

is devoted to

the study of the

properties of the

operator T defined by

$Tf(x) = \int_0^x f(t) dt$

and the operator S defined by

$Sf(x) = \int_0^x \int_0^t f(s) ds dt$

and the operator R defined by

$Rf(x) = \int_0^x \int_0^t \int_0^s f(r) dr ds dt$

and the operator Q defined by

$Qf(x) = \int_0^x \int_0^t \int_0^s \int_0^r f(u) du dr ds dt$

and the operator P defined by

$Pf(x) = \int_0^x \int_0^t \int_0^s \int_0^r \int_0^u f(v) dv du dr ds dt$

and the operator L defined by

$Lf(x) = \int_0^x \int_0^t \int_0^s \int_0^r \int_0^u \int_0^v f(w) dw du dr ds dt$

and the operator M defined by

$Mf(x) = \int_0^x \int_0^t \int_0^s \int_0^r \int_0^u \int_0^v \int_0^w f(z) dz du dr ds dt$

and the operator N defined by

$Nf(x) = \int_0^x \int_0^t \int_0^s \int_0^r \int_0^u \int_0^v \int_0^w \int_0^z f(y) dy du dr ds dt$

and the operator O defined by

$Of(x) = \int_0^x \int_0^t \int_0^s \int_0^r \int_0^u \int_0^v \int_0^w \int_0^z \int_0^y f(x) dx du dr ds dt$

and the operator P defined by

$Pf(x) = \int_0^x \int_0^t \int_0^s \int_0^r \int_0^u \int_0^v \int_0^w \int_0^z \int_0^y \int_0^x f(t) dt du dr ds dt$

and the operator Q defined by

$Qf(x) = \int_0^x \int_0^t \int_0^s \int_0^r \int_0^u \int_0^v \int_0^w \int_0^z \int_0^y \int_0^x \int_0^t f(s) ds du dr ds dt$

and the operator R defined by

$Rf(x) = \int_0^x \int_0^t \int_0^s \int_0^r \int_0^u \int_0^v \int_0^w \int_0^z \int_0^y \int_0^x \int_0^t \int_0^s f(r) dr du dr ds dt$

and the operator S defined by

$Sf(x) = \int_0^x \int_0^t \int_0^s \int_0^r \int_0^u \int_0^v \int_0^w \int_0^z \int_0^y \int_0^x \int_0^t \int_0^s \int_0^r f(s) ds du dr ds dt$

and the operator T defined by

$Tf(x) = \int_0^x \int_0^t \int_0^s \int_0^r \int_0^u \int_0^v \int_0^w \int_0^z \int_0^y \int_0^x \int_0^t \int_0^s \int_0^r \int_0^u f(t) dt du dr ds dt$

The committee recognizes the necessity for the continued development of the research, educational, and quarantine programs of the State and Federal Governments and earnestly recommends the appropriation of the funds necessary to maintain these activities, and expand them when necessary.

After careful and complete investigation of the corn-borer regulatory, research, and educational activities, the committee suggests and recommends:

1. That since the quarantine efforts have been successful in preventing long-distance spread by artificial means, and since the only known spread of any importance in the United States has been by the natural flight of the corn-borer moths or by water drift of infested material, the quarantine activities of the Federal Governments of the United States and Canada should be supported and encouraged by the States and Provincial Agricultural Colleges and Experiment Stations, the State Departments of Agriculture, and all other agencies interested in the welfare of American agriculture.
2. That because the clean-up in certain of the infested areas has not been complete and the borer population is increasing, quarantine action is much more imperative.
3. That scouting should be continued in the areas contiguous to known infested areas and extended to the larger corn-producing States where areas seem particularly exposed to infestation. Ample funds should be available for a thorough clean-up of isolated infestation in such areas.
4. That two primary methods of control of the corn borer are recognized, namely, (a) the utilization or destruction of all host plant remnants each year, and (b) the somewhat later planting of corn. To facilitate the first of these methods labor saving tools and farm machinery should be devised or improved as rapidly as possible.
5. That gratifying progress in European Corn Borer research has been made during the past year.

Certain phases have already yielded results from which conclusions of both practical and technical value have been drawn. On the other hand, the committee wishes to emphasize the necessity for continued effort in each of the major lines of entomology, agronomy, agricultural engineering, agricultural economics and animal husbandry. While certain lines of work have served their purpose and should be discontinued along with those that have been found unfruitful, there are still many problems requiring continued study as well as others yet unattacked and it is urged that future emphasis be given these. In addition, the committee suggests that all major phases be expanded, so far as practicable, into corn-belt States not yet infested with the borer.

Respectfully submitted,

COMMITTEES

American Association of Economic Entomologists

G. A. Dean	D. J. Caffrey
L. Caesar	J. J. Davis
C. J. Drake	

American Society of Agronomy

L. E. Call	J. F. Cox
W. L. Burlison	R. M. Salter
F. D. Richey	

American Society of Agricultural Engineers

C. O. Reed	A. L. Young
S. H. McCrory	R. B. Gray
R. D. Bardon	

American Farm Economic Association

C. R. Arnold	H. M. C. Case
O. G. Lloyd	A. G. Black
C. L. Holmes	

American Society of Animal Production

E. W. Sheets	Paul Gerlaugh
F. G. King	G. A. Brown
F. B. Morrison	

Report of the Committee on Allocation
(1929)

REPORT OF THE COMMITTEE ON ALLOCATION OF THE
EUROPEAN CORN BORER RESEARCH WORK

The Committee on Allocation, as in 1928, accompanied the European corn borer committee appointed by the American Association of Economic Entomologists, the American Society of Agronomy, the American Society of Agricultural Engineers, the American Farm Economic Association, and the American Society of Animal Production on their annual tour of inspection of the corn borer research work in Ohio, Michigan and Ontario. They also met with these committees and assisted in preparing the annual report of the Joint Committee on the European corn borer. This again gave the Allocation Committee an excellent opportunity to become acquainted with the many phases of the corn borer research work. The committee desires to reiterate its statement of a year ago, that it is the unanimous opinion of the committee that while there is some duplication of the research work by various Government and State workers, they have not found any undesirable duplication.

The committee, after spending considerable time in discussing the suggestion made a year ago that the corn borer workers come to some definite agreement or understanding as to what is meant by such terms as larval establishment, larval survival, fodder, stover, knife, blade, stock, plant, etc., decided that the proper definition of terms for which uncertain meaning exists at the present time by the various workers, could best be prepared by the respective societies, and thus it was suggested that each of the respective societies appoint a committee to prepare a complete list of the correct use of the terms for publication in their official journals.

The committee would like to make the following recommendations or suggestions:

1. That if a wide, comprehensive ecological study of the corn borer be undertaken, it be made by or under the general direction of the Federal Government with such cooperation from the States as can be arranged. All investigational activities to be planned to fit into a unified scheme agreed upon by all cooperating groups.

2. That if farm organization and farm management studies be inaugurated in all or part of the Corn Belt States to show the effect of various recommended practices, such as late planting, clean-up of ground unplowed, extra plowing, investment in new machinery, clean plowing, substitute crops, etc., upon the labor distribution and complete production program of the individual farm, as well as the effect upon the ultimate income of the whole farm business, they be made by and under the general direction of the Federal Government in cooperation with State workers.

3. That since it has been fully proven that clean plowing is one of the most effective methods of corn borer control, the experiments in the large screened cages to demonstrate the value of clean plowing should be discontinued.

Respectfully submitted,

G. A. Dean, Chairman
C. O. Reed
L. E. Call
C. R. Arnold
H. G. Crawford
D. J. Caffrey
J. S. Houser
W. P. Flint
R. B. Gray
E. W. Sheets

Committee

